

Photovoltaic (PV) stand-alone systems — Design verification

The European Standard EN 62124:2005 has the status of a
British Standard

ICS 27.160

National foreword

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The UK participation in its preparation was entrusted to Technical Committee GEL/82, Solar photovoltaic energy systems, which has the responsibility to:

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- present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
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**Photovoltaic (PV) stand-alone systems –
Design verification
(IEC 62124:2004)**

Systèmes photovoltaïques (PV)
autonomes –
Vérification de la conception
(CEI 62124:2004)

Photovoltaische (PV)-Inselsysteme -
Bauarteignung und Typprüfung
(IEC 62124:2004)

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Foreword

The text of document 82/355/FDIS, future edition 1 of IEC 62124, prepared by IEC TC 82, Solar photovoltaic energy systems, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 62124 on 2005-02-01.

The following dates were fixed:

- | | | |
|--|-------|------------|
| – latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement | (dop) | 2005-11-01 |
| – latest date by which the national standards conflicting with the EN have to be withdrawn | (dow) | 2008-02-01 |

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 62124:2004 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60721-2-1	NOTE	Harmonized as HD 478.2.1 S1:1989 (not modified).
IEC 61277	NOTE	Harmonized as EN 61277:1998 (not modified).
IEC 61724	NOTE	Harmonized as EN 61724:1998 (not modified).
IEC 61725	NOTE	Harmonized as EN 61725:1997 (not modified).
ISO/IEC 17025	NOTE	Harmonized as EN ISO/IEC 17025:2000 (not modified).

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PHOTOVOLTAIC (PV) STAND-ALONE SYSTEMS – DESIGN VERIFICATION

1 Scope and object

The specifications, test methods and procedures included in this document cover stand-alone photovoltaic (PV) systems. It covers systems containing one or more PV modules, a support structure, storage batterie(s), a charge controller and typical DC loads such as lights, radio, television and refrigerators. AC loads with dedicated inverters are considered as DC loads. The load as specified by the manufacturer is an integral part of the PV system with regards to the design verification.

The focus of the test methods and procedures in this document is limited to system performance evaluation. Individual sub-systems and components may be monitored, but only to evaluate the performance of the overall system.

The results of this test are applicable to the exact components that are tested. Any changes in components or components' specifications require design verification.

NOTE An exception to this rule is the load. Retesting is not necessary, if the nominal power of the load and its characteristics are not altered, always provided that the new loads are also type tested (provided a type test is available) and the operation frequency of the loads electronics controller (if any) do not vary more than 50 % from the new one to the one tested and being replaced. Hence, the replacement of a pure ohmic load by lights using high frequency electronic ballasts would require retesting, but not the change from one electronic lighting product to another one.

The standard is valid for system testing both for outdoors in prevailing conditions and indoors under simulated conditions. The testing conditions are intended to represent the majority of climatic zones for which these systems are designed.

The object of this standard is to verify system design and performance of stand-alone photovoltaic systems. While individual components may be qualified to environmental and safety standards, the assembled system needs further verification, to ensure that the components operate properly together as specified by the system manufacturer. The performance test consists of a check of the functionality, the autonomy and ability to recover after periods of low state-of-charge of the battery, and hence gives reasonable assurance that the system will not fail prematurely.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60364-7-712, *Electrical installations of buildings – Part 7-712: Requirements for special installations or locations – Solar photovoltaic (PV) power supply systems*

IEC 60904-1, *Photovoltaic devices – Part 1: Measurement of photovoltaic current-voltage characteristics*

IEC 60904-2, *Photovoltaic devices – Part 2: Requirements for reference solar cells*

IEC 60904-5:1993, *Photovoltaic devices – Part 5: Determination of the equivalent cell temperature (ECT) of photovoltaic (PV) devices by the open-circuit voltage method*

IEC 61215, *Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval*

IEC 61646, *Thin-film silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval*

IEC 61730-1, *Photovoltaic (PV) module safety qualification – Part 1: Requirements for construction*

IEC 61730-2, *Photovoltaic (PV) module safety qualification – Part 2: Requirements for testing*

IEC 62093, *Balance-of-system components for photovoltaic systems – Design qualification* ¹

3 Acronyms

AC	Alternating current
DAS	Data acquisition system
DC	Direct current
DRT	Daily run time (of the load)
FS	Full screen
HVD	High voltage disconnect (of the charge controller)
LVD	Low voltage disconnect (of the charge controller)
NOCT	Nominal operating cell temperature
PV	Photovoltaic(s)
STC	Stand testing conditions
UBC	Usable battery capacity
VI	Visual inspection

4 Testing methods

4.1 Methods

The procedures of the performance test are subdivided into 3 different tests: the functional test, the autonomy test and the recovery test. Outdoor and indoor tests are feasible.

¹ To be published.

It is recommended that an outdoor test be only performed if the outdoor testing conditions at the testing site are similar to the outdoor conditions simulated in this standard. If the outdoor conditions at the testing site greatly differ, an indoor test is recommended.

The tests in this standard are performed under conditions of irradiance and temperature that cover a large part of the world in which these systems are being installed. However these tests can be adapted to meet specific climatic conditions, if these are significantly different from the testing conditions in this standard.

4.2 Sampling

Two complete systems for verification testing (plus spares as specified by the supplier) shall be taken at random from a production batch or batches. The systems shall have been manufactured from specified materials and components in accordance with the relevant drawings and process sheets and have been subjected to the manufacturer's normal inspection, quality control and production acceptance procedures. The systems shall be complete in every detail and shall be accompanied by the manufacturer's handling, mounting and connecting instructions, including safety instructions.

It is also essential that the batteries in the systems to be tested, which are an integral part of the design verification, are identical to the batteries which are later going to be sold in the field.

A copy of the relevant test certificate of the PV modules, charge controllers, batteries and lamps shall be included.

When the systems to be tested are prototypes of a new design and not from production, this fact shall be noted in the test report (see Clause 19).

5 Marking

The manufacturer shall provide equipment, sub-units and plug-in parts of the system with the following clear and indelible markings:

- name, monogram or symbol of the manufacturer/supplier;
- type or model number;
- supply voltage, kind of voltage and frequency;
- serial or batch number;
- polarity of terminals or leads;
- connecting points for the incoming conductors;
- precautionary warning concerning special requirements for storage or handling.

The date and place of manufacture shall be marked on the component or be traceable from the serial number.

All components shall be provided with relevant documents concerning their rating, certificates and specifications in the language of the user and/or technician. Instead of a written user's manual, illustrations may be used where appropriate.

Labelling on equipment shall be in accordance with good ergonomic principles so that warning notices, controls, indications, test facilities, fuses, etc., are sensibly placed and logically grouped to facilitate correct and unambiguous identification.

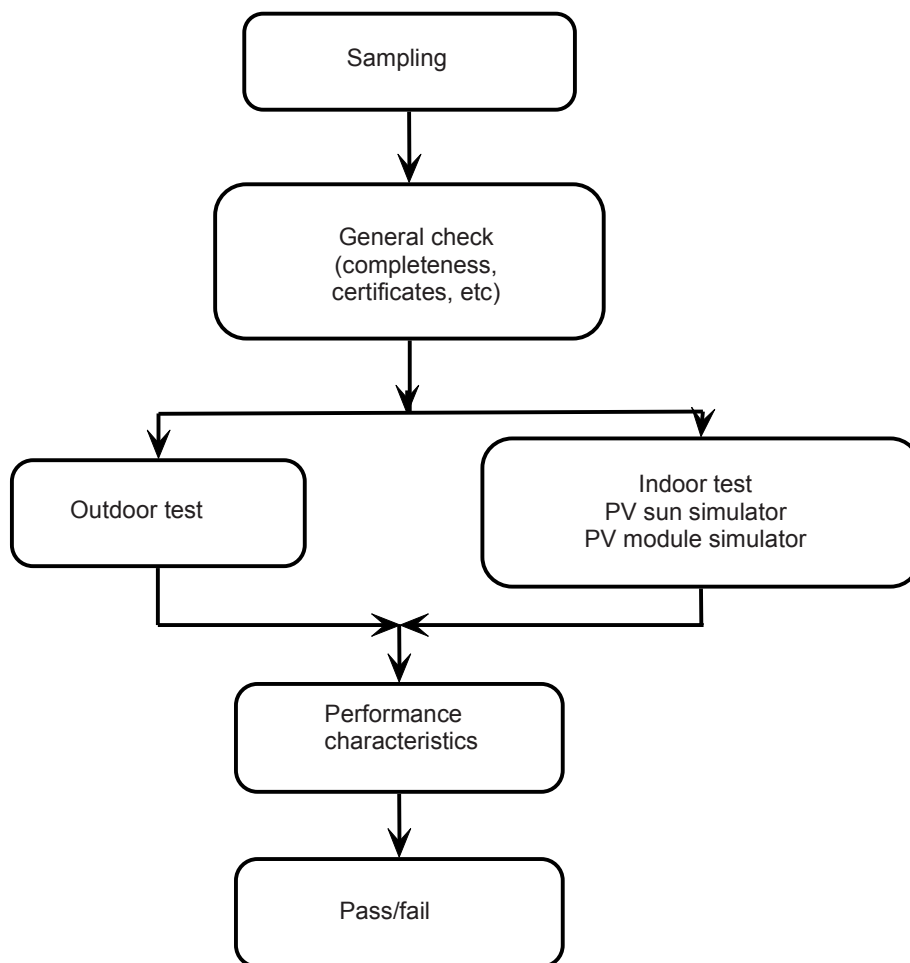
6 Testing

The system shall be subjected to the test sequences in this standard, carried out in the order laid down.

In carrying out the tests, the tester shall strictly observe the manufacturer's handling, mounting and connection instructions.

Should one of the 2 previously sampled systems fail any test, another system meeting the requirements of 4.2 shall be subjected to the whole of the relevant test sequence from the beginning. If this system also fails, the design shall be deemed not to have met the verification requirements.

Figure 1 represents the verification process.



IEC 1333/04

Figure 1 – Flow diagram representing the verification process

7 Pass criteria

A system design shall be judged to have passed the verification test, if each test sample meets all the following criteria:

7.1 System completeness

The system shall be complete, i.e. contain the following elements.

- All the necessary hardware.
- Specification by the manufacturer concerning daily run time (DRT) under testing conditions. An important design parameter is the size of the load and the daily number of hours the system can service the load under testing conditions (DRT). Reference is made to Annex A for the irradiation class II. Daily run time under testing conditions shall be stated by the manufacturer. In addition, the manufacturer shall specify the classification of the system under testing conditions (see Annex A).
- Specification by the manufacturer concerning the design load (Wh), the irradiation level for which this design load can be energized by the system, the autonomy and the classification under design conditions (see Annex A). These specifications enable the test lab to verify the manufacturer's calculations.
- Specification by the manufacturer concerning the days of autonomy under testing conditions.
- Certificates (see 7.2).
- User manual, including list of spare parts and tools, as laid down in Clause 9.
- Technicians' manual as laid down in Clause 10 shall be supplied for installation, operation and maintenance.

7.2 Certificates

PV-modules, charge controller, battery and the relevant loads such as lighting or others as specified by the manufacturer and included in the set shall bear a type approval certificate from an internationally recognised PV quality system.

The PV modules shall be qualified according to IEC 61215, IEC 61730-1 and IEC 61730-2 in the case of crystalline silicon PV modules and according to IEC 61646, IEC 61730-1 and IEC 61730-2 in the case of thin film PV modules.

The Balance-Of-System (BOS) components shall be qualified according to IEC 62093.

7.3 Performance tests

The system shall pass the performance tests laid down in Clause 13.

The following pass/fail criteria apply:

- 1) the load shall function at all stages of the test unless the charge controller has disconnected the load due to a low battery state of charge. (If LVD occurred, this data shall be noted);
- 2) the battery capacity shall not decrease over the testing period more than 10 %, expressed by $(UBC_0 - UBC_2) / UBC_0 < 10 \%$ (see Figure 2 for the signification of UBC);

- 3) recovery: the 'recovery test' should exhibit an upward trend in the system voltage. During the recovery test, the total net Ah into the battery should be ≥ 50 % of UBC_1 ;
- 4) after capacity test UBC_1 , the load shall begin operating again on or before the third 'recovery test' cycle;
- 5) the system balance point (see system characterisation plot) shall match the defined minimum irradiation class or be below it;
- 6) the measured days of autonomy shall match the defined minimum days of autonomy as indicated by the manufacturer or be above it;
- 7) the load shall operate undamaged according to the manufacturer's specification at the maximum battery voltage occurring during periods of high irradiance and at high state of charge;
- 8) no sample shall exhibit any abnormal open-circuit or short-circuit during the tests.

7.4 Visual evidence of a major defect

There shall be no visual evidence of a major defect, as defined in Clause 11, both before and after the performance test, as laid down in Clause 13.

7.5 Design specifications

The design specifications laid down in Clause 8 shall be met.

8 Design specifications

8.1 Prevention against battery discharge into the module(s)

Battery discharge into the module(s) shall be minimised. The means by which this is achieved shall be documented. If blocking diodes are used, the current capacity shall be 50 % higher than the short circuit current (at STC). The peak inverse voltage of the diode shall be at least double the open circuit battery voltage.

In any event, battery discharge should not exceed energy losses associated with a blocking diode.

8.2 Support structure and foundation

The manufacturer shall provide calculations/evidence that the support structure, with the PV modules mounted, is able to withstand the design wind speed.

Any outdoor structure, including hardware for all external connections, shall be corrosion resistant. The manufacturer shall provide proof (calculation/evidence) of adequate resistance.

8.3 Wiring

Electrical connections shall, by design, be mechanically robust to minimise loosening by thermal cycling and provide adequate strain relief.

Between solar modules and the charge controller, only water resistant, mechanically robust and UV resistant cables shall be used.

The continuous maximum current rating of the conductors (after any deratings for temperature or installation conditions) in PV source and output circuits shall be at least 125 % of I_{sc} (short circuit current) and shall not be less than the rating of any overcurrent device protecting those conductors.

- Calculate or measure the voltage drop from the module(s) to the battery, excluding diode losses and list it in the test report. Typically, it shall be less than 5 % at full current load.
- Calculate or measure the voltage drop from the battery to the load and list it in the test report. Typically, it shall be less than 5 % at full current load.

All wiring shall be colour coded and/or labelled.

8.4 Connectors

Splices and connections in module wiring shall be made using devices and tools approved by the manufacturer, and shall be installed using instructions provided with the device. The devices shall be suitable for the environment, provide appropriate physical protection including strain relief, and the spliced or connected conductor shall have at least the same mechanical and electrical conduction and insulation properties as the unspliced wire.

All connectors shall be polarised and be able to withstand 156 % of the short circuit current at STC.

The rated current carrying capacity of the joint shall not be less than the circuit current rating.

8.5 Fuses and circuit breakers

The battery shall be protected against short-circuit by a fuse(s), as close as possible to the battery terminal(s).

Where fuses of different capacity are installed, they shall have clear colour coding or labelling or be of different physical size.

Fuses shall:

- be sized per the conductor size and per the component they are protecting as specified by the manufacturer,
- be rated for the environment they are going to be used in (care shall be taken to ensure that corrosion or explosion by battery gasses is avoided),
- be marked with rated current, voltage and use (AC or DC),
- be rated for DC service in DC applications,
- have appropriate voltage ratings for the circuit they are protecting.

Overcurrent devices protecting PV source and output circuits and carrying currents from the PV modules shall be rated for 156 % of I_{sc} (short circuit current) and shall have a voltage rating of 125 % V_{oc} (open circuit voltage).